

## The oceans are becoming more acidic. What does this mean for shellfishing in Maine?

### What are acids?

You can find acids all around you in your everyday lives, from your morning coffee, to vinegar, to the liquid in your car battery. An item is an acid when it gives off Hydrogen ions ( $H^+$ ) when it is mixed with water. The more hydrogen ions it gives off, the more acidic it is. All these  $H^+$  ions give the liquid a positive charge, so the liquid reacts with different substances to take ions with negative charges so that the total charge returns to neutral. This is why acids can cause things to dissolve. A value called pH is used to express the amount of acidity.

### What does the pH value mean?

pH is a scale ranging from 1 to 14. Because of the way pH is calculated, the numbers mean the opposite of what you might first expect: a **lower** number means it has a **higher acidity** and has more  $H^+$  ions, and a **higher** number means it has a **lower acidity** and has less  $H^+$  ions. pH is a log scale, so each number on the scale from 14 to 1 has 10x more  $H^+$  ions.

### What's the average pH of the ocean?

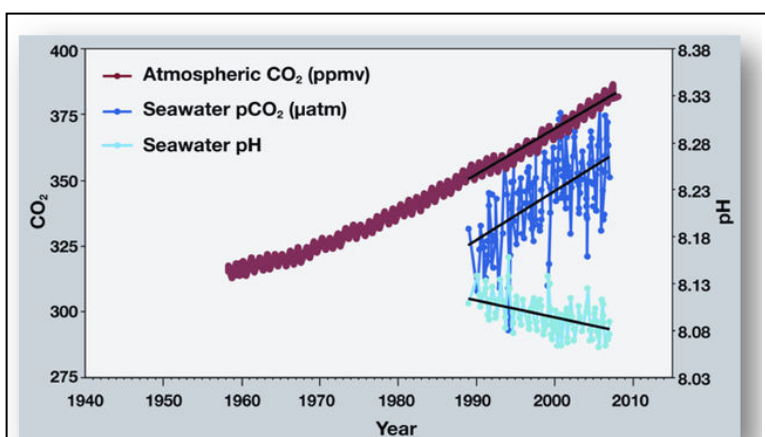
The present day average pH of the ocean is 8.07.

### What's the average pH of rainfall?

The average pH of rain is 5.6.

### How are oceans becoming more acidic?

Oceans are becoming more acidic because the burning of greenhouse gasses has greatly increased the amount of carbon dioxide in the atmosphere. This carbon dioxide gas interacts with water on the surface of the earth, as well as in the atmosphere to form an acid called carbonic acid. As the amount of carbon dioxide in the atmosphere increases, the amount of carbonic acid in rainwater and ocean water will also increase, resulting in increased acidity of rainfall and oceans. Over the past 100 years, the pH of ocean water has decreased from 8.16 to about 8.07 today. This change of about 0.1 on the pH scale translates to a 30% increase in the amount of  $H^+$  ions in the ocean.



This graph shows the correlation between rising levels of carbon dioxide ( $CO_2$ ) in the atmosphere at Mauna Loa with rising  $CO_2$  levels in the nearby ocean at Station Aloha. As more  $CO_2$  accumulates in the ocean, the pH of the ocean decreases. (Modified after R.A. Feely, Bulletin of the American Meteorological Society, July 2008)

Source: NOAA PMEL Carbon Program

(<http://www.pmel.noaa.gov/co2/story/Ocean+Acidification>)

### Why does ocean acidity impact shellfish?

Acidification of the oceans has a particularly strong impact on shellfish because shells are made of calcium carbonate. The old fizzing vinegar on baking soda trick works the way it does because baking soda, sodium bi-carbonate, also has a carbonate ( $CO_3^{2-}$ ). Carbonate dissolves easily in acids because of its negative charge. In order for shellfish to make shells, they must be able to take dissolved carbonate out of the water. This is only possible when the water is oversaturated with carbonate – there is more carbonate with a negative charge than is needed to bond with the positively charged hydrogen to make it neutral. The higher the acidity (lower pH), the more carbonate the water can absorb, and the less



carbonate is available for shellfish. For shellfish areas to naturally reseed, the acidity must be low enough (higher pH) for young clams to be able to take dissolved carbonate out of the water and begin forming a shell. Once that shell is formed, the acidity must remain low so that the young fragile shells do not begin to dissolve.

### **What have shellfishing communities in Maine done to confront this issue?**

After experiencing little to no natural sets of softshell clams and learning about the impacts of ocean acidification, the Wiscasset Shellfish Committee looked into ways to improve their shellfish flats. One thing they found was research completed in West Bath by Professor Mark Green, from St. Joseph's College of Maine. This research showed an increase of pH on clam flats and a viable set of juvenile clams after 4 oz. per square foot of crushed clam shells were spread across the flats. The Wiscasset Shellfish Committee decided to carry out this project with the same specifications on a larger scale in their town. They worked closely with DMR and DEP to set up the project. Over two years, members of the shellfish committee spread 12 tons of crushed clam shells over 7 shellfish flats, finishing this September. The town obtained the clam shells from an approved shellfish dealer. The results are still inconclusive, and it will take a few years to see the full impact that this shell project has on Wiscasset shellfish flats, but so far, the flats appear to be seeding well.

### **Ocean Acidification in Maine**

To read more about the research and impact of ocean acidification on shellfish flats in Maine, check out an article called 'Dead Muds' by Seth Koenig of the Bangor Daily News at <http://bangordailynews.com/2011/10/07/environment/shellfish-harvesters-plagued-by-acidic-%E2%80%98dead-muds%E2%80%99/>.